FieldPoint™ Operating Instructions

FP-QUAD-510 and cFP-QUAD-510

Four-Axis Quadrature Input Module

These operating instructions describe how to install and use the National Instruments FP-QUAD-510 and cFP-QUAD-510 quadrature input modules (referred to inclusively as the [c]FP-QUAD-510). For information about configuring and accessing the [c]FP-QUAD-510 over a network, refer to the user manual for the FieldPoint network module you are using.

Features

The [c]FP-QUAD-510 is a FieldPoint quadrature input module with the following features:

- Four position counters, each with Phase A, Phase B, and Index input terminals
- Velocity measurement
- 32-bit counters with LabVIEW RT
- Programmable reset on index mode
- Inputs compatible with TTL and differential encoders
- 2,300 V_{rms} transient overvoltage protection
- –40 to 70 °C operation
- Hot swappable

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Power Requirement

The [c]FP-QUAD-510 is powered by the FieldPoint network module through the terminal base or backplane. The [c]FP-QUAD-510 requires up to 1.2 W of power, which may limit the number of I/O modules that you can connect to a single network module.

Before you configure a FieldPoint system that uses a [c]FP-QUAD-510 module, calculate the total power consumption of the I/O modules on the FieldPoint bank. You can find the power requirement specification in the operating instructions for each I/O module. The maximum power the network module can supply is specified in the network module user manual. Make sure the total power requirement for all of the I/O modules in the bank is less than the maximum power available from the network module.

Suppose you have a bank with an FP-2000 network module, four FP-QUAD-510 modules, and five FP-DI-301 modules. The FP-2000 can supply up to 9 W. The FP-QUAD-510 requires 1.2 W and the FP-DI-301 requires 0.325 W. The four FP-QUAD-510 and five FP-DI-301 modules require a total of 6.4 W:

$$4 \times 1.2 \text{ W} + 5 \times 0.325 \text{ W} = 6.4 \text{ W}$$

This power requirement is less than the 9 W maximum.

Installing the FP-QUAD-510

The FP-QUAD-510 mounts on a FieldPoint terminal base (FP-TB-*x*), which provides operating power to the module. Installing the FP-QUAD-510 onto a powered terminal base does not disrupt the operation of the FieldPoint bank.

To install the FP-QUAD-510, refer to Figure 1 and complete the following steps:

1. Slide the terminal base key to either position X, used for any module, or position 8, used for the FP-QUAD-510.
2. Align the FP-QUAD-510 alignment slots with the guide rails on the terminal base.
3. Press firmly to seat the FP-QUAD-510 on the terminal base. When the module is firmly seated, the terminal base latch locks it into place.

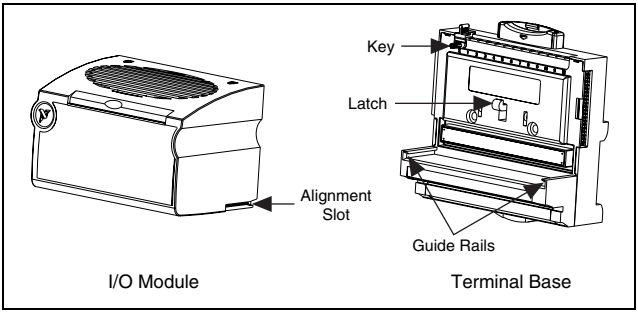


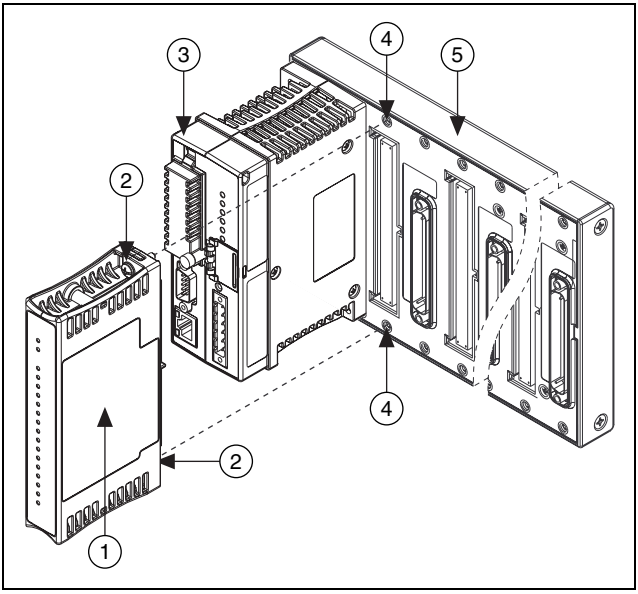
Figure 1. Installing the FP-QUAD-510

Installing the cFP-QUAD-510

The cFP-QUAD-510 mounts on a Compact FieldPoint backplane (cFP-BP-*x*), which provides operating power to the module. Installing the cFP-QUAD-510 onto a powered backplane does not disrupt the operation of the FieldPoint bank.

To install the cFP-QUAD-510, refer to Figure 2 and complete the following steps:

1. Align the captive screws on the cFP-QUAD-510 with the holes on the backplane. The alignment keys on the cFP-QUAD-510 prevent backward insertion.
2. Press firmly to seat the cFP-QUAD-510 on the backplane.
3. Using a number 2 Phillips screwdriver with a shank of at least 64 mm (2.5 in.) length, tighten the captive screws to 1.1 N · m (10 lb · in.) of torque. The nylon coating on the screws prevents them from loosening.



1	cFP-QUAD-510	4	Screw Holes
2	Captive Screws	5	cFP Backplane
3	cFP Controller		

Figure 2. Installing the cFP-QUAD-510

Wiring the [c]FP-QUAD-510

The FP-TB-*x* terminal base provides connections for each axis, for +5 V output to encoders, and for an external supply to power the FP-QUAD-510 input channels and the +5 V output. The cFP-CB-*x* connector block provides the same connections for the cFP-QUAD-510. The V terminals are all internally connected, as are the +5 V terminals. All the C and COM terminals are also internally connected.

Use an 8–30 VDC, 5 W external power supply for the input channels and the +5 V outputs. Connect the power supply to the V and C terminals.

Caution If you are using a cFP-QUAD-510 in the 60–70 °C temperature range, connect an external power supply directly to the voltage input of the encoder and do not use the +5 V output terminal.

Install a 2 A maximum, fast-acting fuse between the external power supply and the V terminal.

Table 1 lists the terminal assignments for the signals of each axis. +A and –A represent the Phase A signals, +B and –B represent the Phase B signals, and +I and –I represent the Index signals. Terminal assignments are also listed on the side panel of the cFP-QUAD-510 and under the slide-in card on the front of the FP-QUAD-510.

Table 1. Terminal Assignments

	Terminal Numbers			
Signal	**Axis 0**	**Axis 1**	**Axis 2**	**Axis 3**
+A	1	5	9	13
–A	17	21	25	29
+B	2	6	10	14
–B	18	22	26	30
+I	3	7	11	15
–I	19	23	27	31
+5 V	4	8	12	16
COM	20	24	28	32

The [c]FP-QUAD-510 accepts two types of encoder signal inputs: single-ended (TTL) and differential line driver. Figure 3 shows the typical encoder wiring for single-ended signal input. Connect only one terminal for each input signal as shown in Figure 3.

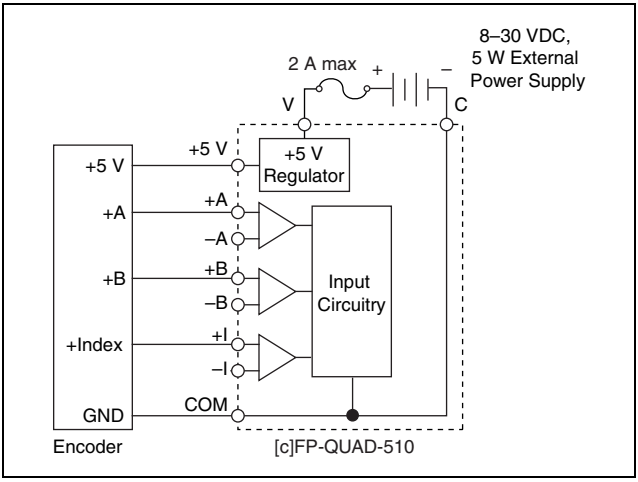


Figure 3. Basic Field Connections to Single-Ended Encoders

Figure 4 shows the typical encoder wiring for differential signal input.

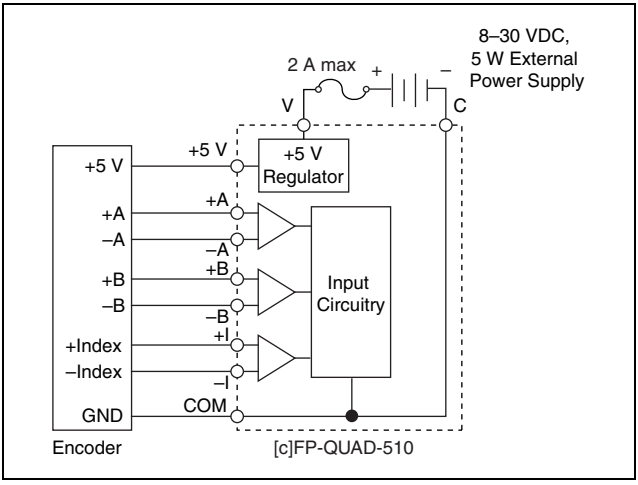


Figure 4. Basic Field Connections to Differential Encoders

The [c]FP-QUAD-510 supports differential inputs for Phase A, Phase B, and Index signals. You can easily accommodate encoders

with various phase relationships by swapping the signals and/or connecting them to the inverting inputs as specific applications require. If the index polarity is inverted, try reversing the +Index and –Index signals on differential encoders or using the –Index input on single-ended encoders.

Power for a +5 V encoder is also provided for each axis. If you are using an encoder that requires a different voltage level, reference an external supply to either the C terminal or the COM terminal.

Configuring [c]FP-QUAD-510 Channels

Table 2 summarizes the functionality of each [c]FP-QUAD-510 channel as accessed through FieldPoint software.

Table 2. [c]FP-QUAD-510 Channel Operation Summary

Channel Number	Channel Description	Type	Range
0	Position LSB[1] 0	Count Input	0–65,535
1	Position LSB 1	Count Input	0–65,535
2	Position LSB 2	Count Input	0–65,535
3	Position LSB 3	Count Input	0–65,535
4	Position MSB[2] 0	Count Input	0–65,535
5	Position MSB 1	Count Input	0–65,535
6	Position MSB 2	Count Input	0–65,535
7	Position MSB 3	Count Input	0–65,535
8	Velocity 0	Analog Input	8 Ranges
9	Velocity 1	Analog Input	8 Ranges
10	Velocity 2	Analog Input	8 Ranges
11	Velocity 3	Analog Input	8 Ranges
12	Index 0	Digital Input	Boolean
13	Index 1	Digital Input	Boolean
14	Index 2	Digital Input	Boolean
15	Index 3	Digital Input	Boolean

[1] Least significant bit
[2] Most significant bit

Configuring Position Counters

Channels 0 to 7 are 16-bit position counters. Channels 0 to 3 contain the 16 least significant bits (LSB) of axes 0 to 3 respectively. Channels 4 to 7 contain the 16 most significant bits (MSB) of axes 0 to 3 respectively.

In order to use 32-bit counters, you must create your application in LabVIEW RT and run it embedded on a FieldPoint RT controller. For all other application software, use 16-bit counters. Complete the following steps to create a 32-bit position counter for axis 0:

1. In FieldPoint software, create a new item for the [c]FP-QUAD-510.
2. Give the new item a descriptive name such as “Axis 0 Counter.”
3. Select channels 0 and 4.
4. Click **OK**.
5. Combine channels 0 and 4 in your LabVIEW RT application.

Refer to `ni.com/support` for an example program that shows how to use a 32-bit counter with FieldPoint and LabVIEW RT.

Position Counter Input Circuit

The circuit for the position counter inputs consists of a comparator with current-limited inputs to convert signals from differential to single-ended. The output of the comparator drives an optoisolator. When you apply a voltage above the threshold voltage to the input terminal, the comparator turns on the optoisolator, registering in an ON state.

The inputs are designed to be compatible with single-ended TTL encoders or differential encoders supplying a differential voltage of at least ±0.3 V. Refer to the *Specifications* section for more information about the threshold voltage levels for TTL and differential input.

The [c]FP-QUAD-510 supports X4 encoding, which uses four counts per period, as shown in Figure 5. Each phase input is rated for frequencies up to 250 kHz. Because there are four counts per period, each axis can count up to one million counts per second.

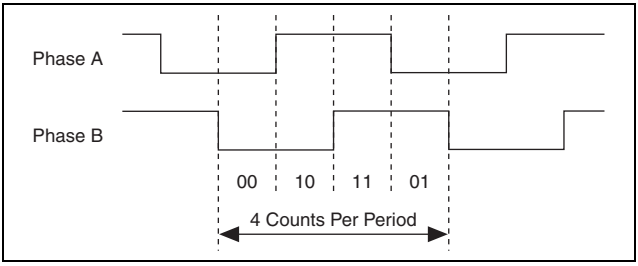


Figure 5. Quadrature Encoder Counts/Period Relationship

Reset on Index Capability

Reset Mode is a channel attribute that you can set in FieldPoint software. In Reset on Index mode, each position counter resets both the upper and lower 16-bit registers each time the index condition is met. This is useful in applications in which only the position within one rotation of the encoder is important to the user. In this mode of operation, any position count errors that occur are canceled when the index condition is met. Refer to the *Configuring Index Status Channels* section for more information about the index.

Commands

In FieldPoint software, you can send **Reset** commands to channels 0 to 3. The Reset command resets both the upper and lower 16-bit registers of the counter. For example, sending a reset command to channel 0 resets both channels 0 and 4.

Configuring Velocity Data Channels

The [c]FP-QUAD-510 uses a timebase counter to determine the rate of change of position (velocity) for each axis. The four velocity data registers, channels 8 to 11, contain velocity data for axes 0 to 3 respectively. The data in each register represents the velocity of the axis in number of counts per microsecond. A positive number indicates motion in the forward direction, and a negative number indicates motion in the reverse direction. Figure 6 shows one period of forward motion and one period of reverse motion.

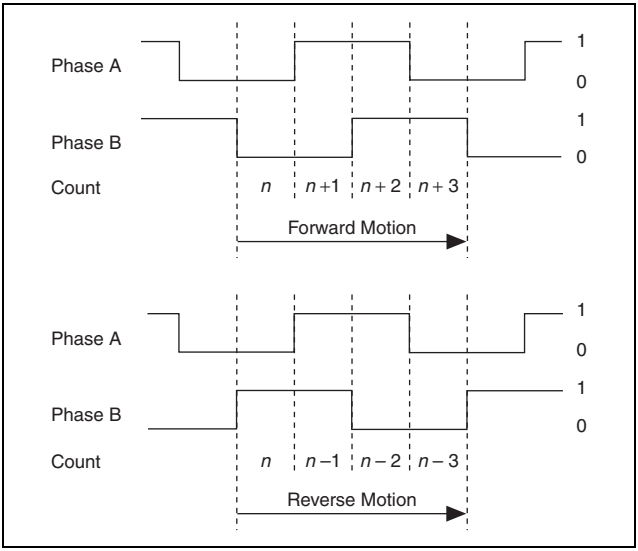


Figure 6. Forward and Reverse Motion and Resulting Counts

You can configure each register independently with one of eight velocity ranges, as shown in Table 3. Each range is based on a different timebase length and has a different resolution.

Table 3. Velocity Ranges

Length of Timebase (µs)	Velocity Range (counts/µs)	Velocity Resolution
204.8	±160	4,883 counts/s
409.6	±80	2,441 counts/s
819.2	±40	1,221 counts/s
1,638.4	±20	610.4 counts/s
3,276.8	±10	305.2 counts/s
6,553.6	±5	152.6 counts/s
13,107.2	±2.5	76.29 counts/s
26,214.4	±1.25	38.15 counts/s

The velocity range is the maximum velocity that can be measured for a given timebase. The velocity register uses a 15-bit counter, which gives a maximum number of counts of 2^{15}, or 32,768. Therefore, the velocity range for a given timebase is calculated using the following formula:

$$V_{rng} = \frac{\pm 32768}{T}$$

where V_{rng} is the velocity range in counts per microsecond and T is the timebase in microseconds.

The velocity resolution for a given timebase is determined by the following formula:

$$V_{res} = \frac{1 \times 10^{6} counts}{T}$$

where V_{res} is the velocity resolution in counts per second and T is the timebase in microseconds.

Configuring Index Status Channels

The [c]FP-QUAD-510 has four channels, 12 to 15, which contain the values of the index signals for axes 0 to 3, respectively. Index value is latched at 1 when the condition at the axis inputs is Phase A = 0, Phase B = 0, and Index = 1. Index value remains latched at 1 until you read the channel in software, and then it is reset to 0. The Index signal must occur when both Phase A and Phase B signals are low, as shown in Figure 7.

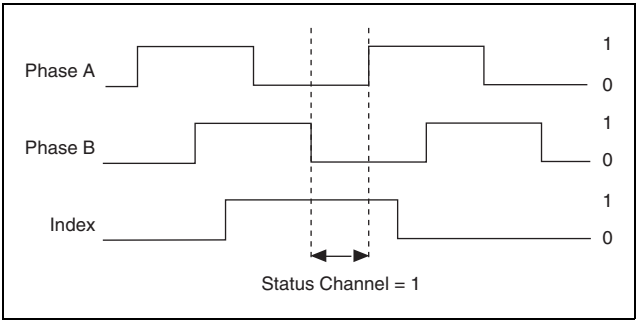


Figure 7. Encoder Signal Phasing

Note If the axis is stopped while the status channel is 1, reading the value of the status channel resets the channel to 0. However, since the index channel is still 1, the status channel immediately returns to 1.

If the Reset on Index attribute is selected, then the status channel does not need to be read between successive index pulses in order for the position counters to reset. The position counters respond to index pulses as programmed regardless of the state of the status channel. For more information about Reset on Index and other attributes, refer to the *Configuring Position Counters* section.

Status Indicators

The [c]FP-QUAD-510 has two green status LEDs, **POWER** and **READY**. After you install the [c]FP-QUAD-510 onto a terminal base or backplane and apply power to the connected network module, the green **POWER** indicator lights and the [c]FP-QUAD-510 informs the network module of its presence. When the network module recognizes the [c]FP-QUAD-510, it sends initial configuration information to the [c]FP-QUAD-510. After the [c]FP-QUAD-510 receives this initial information, the green **READY** indicator lights and the module is in normal operating mode.

Upgrading the FieldPoint Firmware

You may need to upgrade the FieldPoint firmware when you add new I/O modules to the FieldPoint system. For information on determining which firmware you need and how to upgrade, go to `ni.com/info` and enter `fpmatrix`.

Isolation and Safety Guidelines

Caution Read the following information before attempting to connect the [c]FP-QUAD-510 to any circuits that may contain hazardous voltages.

This section describes the isolation of the [c]FP-QUAD-510 and its compliance with international safety standards. The field wiring connections are isolated from the backplane and the inter-module communication bus. The isolation is provided by the module, which has optical and galvanic isolation barriers designed and tested to protect against transient fault voltages of up to 2,300 V_{rms}.

Follow these guidelines to ensure a safe total system:

- The [c]FP-QUAD-510 has a safety isolation barrier between the I/O channels and the inter-module communication bus. There is no isolation between channels unless otherwise noted. If any of the channels on a module are wired at a hazardous potential, make sure that all other devices or circuits connected to that module are properly insulated from human contact.
- Do *not* share the external supply voltages (the V and C terminals) with other devices (including other FieldPoint devices), unless those devices are isolated from human contact.
- For Compact FieldPoint, you *must* connect the protective earth (PE) ground terminal on the cFP-BP-*x* backplane to the system safety ground. The backplane PE ground terminal has the following symbol stamped beside it: ⏚. Connect the backplane PE ground terminal to the system safety ground using 14 AWG (1.6 mm) wire with a ring lug. Use the 5/16 in. panhead screw shipped with the backplane to secure the ring lug to the backplane PE ground terminal.
- As with any hazardous voltage wiring, make sure that all wiring and connections meet applicable electrical codes and commonsense practices. Mount terminal bases and backplanes in an area, position, or cabinet that prevents accidental or unauthorized access to wiring that carries hazardous voltages.
- Operate the [c]FP-QUAD-510 only at or below Pollution Degree 2. Pollution Degree 2 means that only nonconductive pollution occurs in most cases. Occasionally, however, a temporary conductivity caused by condensation must be expected.
- Refer to the FieldPoint product label for regulatory certification under hazardous location standards. If the FieldPoint product is not certified for operation in hazardous locations, do not operate it in an explosive atmosphere or where there may be flammable gases or fumes.

Specifications

The following specifications are typical for a range of –40 to 70 °C unless otherwise noted.

Encoder Input

Number of channels 4

Input type

Single-ended..... V_{IL} = 0.0–0.8 V
V_{IH} = 2.0–30.0 V

Differential

High ..... $(V_{IN}^{-} + 0.3\ V) \leq V_{IN}^{+} \leq 30\ V$
$0\ V \leq V_{IN}^{-} \leq 3.0\ V$

Low ..... $0\ V \leq V_{IN}^{+} \leq 3.0\ V$
$(V_{IN}^{+} + 0.3\ V) \leq V_{IN}^{-} \leq 30.0\ V$

Input bandwidth ..... 250 kHz for each input

Encoder frequency ..... 1 million counts/second

Minimum input pulse width..... 2 µs

Counter width ..... 32 bits, 4,294,967,295 counts

External supply voltage ..... 8–30 VDC, user-provided at 5 W

Encoder supply voltage..... 5 VDC ± 0.25 V at 600 mA maximum[1]

Physical Characteristics

Indicators ..... Green **POWER** and **READY** indicators

Weight

FP-QUAD-510 ..... 143 g (5.1 oz)

cFP-QUAD-510..... 113 g (4.0 oz)

Power Requirements

Power from network module ..... 1.2 W maximum

[1] The maximum current for all four +5 V output terminals combined is 600 mA.

Isolation Voltage

Channel-to-channel isolation ..... No isolation between channels

Transient overvoltage ..... 2,300 V_{rms}

Environmental

FieldPoint modules are intended for indoor use only. For outdoor use, they must be mounted inside a sealed enclosure.

Operating temperature ..... –40 to 70 °C[1]

Storage temperature ..... –55 to 85 °C

Humidity ..... 10 to 90% RH, noncondensing

Maximum altitude ..... 2,000 m; at higher altitudes the isolation voltage ratings must be lowered

Pollution Degree 2

Shock and Vibration

These specifications apply only to the cFP-QUAD-510. NI recommends Compact FieldPoint if your application is subject to shock and vibration.

Operating vibration, random (IEC 60068-2-64) ..... 10–500 Hz, 5 g_{rms}

Operating vibration, sinusoidal (IEC 60068-2-6) ..... 10–500 Hz, 5 g

Operating shock (IEC 60068-2-27) ..... 50 g, 3 ms half sine, 18 shocks at 6 orientations; 30 g, 11 ms half sine, 18 shocks at 6 orientations

[1] If you are using a cFP-QUAD-510 in the 60 to 70 °C temperature range, use an external power supply for the encoder and do not use the +5 V terminal.

Safety

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 3121-1, UL 61010C-1
- CAN/CSA C22.2 No. 1010.1

For UL, hazardous location, and other safety certifications, refer to the product label or to `ni.com`.

Electromagnetic Compatibility

CE, C-Tick, and FCC Part 15 (Class A) Compliant

Emissions ..... EN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

Immunity ..... EN 61326:1997 + A2:2001, Table 1

Note For EMC compliance, you *must* operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

Low-Voltage Directive (safety) 73/23/EEC

Electromagnetic Compatibility
Directive (EMC) 89/336/EEC

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, click **Declarations of Conformity Information** at `ni.com/hardref.nsf/`.

Mechanical Dimensions

Figure 8 shows the mechanical dimensions of the FP-QUAD-510 installed on a terminal base. If you are using the cFP-QUAD-510, refer to your Compact FieldPoint controller user manual for the dimensions and cabling clearance requirements of the Compact FieldPoint system.

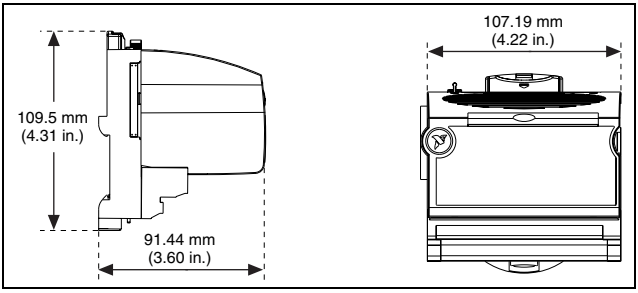


Figure 8. FP-QUAD-510 Mechanical Dimensions

Where to Go for Support

For more information about setting up the FieldPoint system, refer to these National Instruments documents:

- FieldPoint network module user manual
- Other FieldPoint I/O module operating instructions
- FieldPoint terminal base and connector block operating instructions

Go to `ni.com/support` for the most current manuals, examples, and troubleshooting information.

For telephone support in the United States, create your service request at `ni.com/support` and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 0 662 45 79 90 0,
Belgium 32 0 2 757 00 20, Brazil 55 11 3262 3599,
Canada (Calgary) 403 274 9391,
Canada (Montreal) 514 288 5722,
Canada (Ottawa) 613 233 5949, Canada (Québec) 514 694 8521,
Canada (Toronto) 905 785 0085,
Canada (Vancouver) 514 685 7530, China 86 21 6555 7838,

Czech Republic 420 2 2423 5774, Denmark 45 45 76 26 00,
Finland 385 0 9 725 725 11, France 33 0 1 48 14 24 24,
Germany 49 0 89 741 31 30, Greece 30 2 10 42 96 427,
India 91 80 51190000,
Israel 972 0 3 6393737, Italy 39 02 413091,
Japan 81 3 5472 2970, Korea 82 02 3451 3400,
Malaysia 603 9131 0918, Mexico 001 800 010 0793,
Netherlands 31 0 348 433 466, New Zealand 0800 553 322,
Norway 47 0 66 90 76 60, Poland 48 0 22 3390 150,
Portugal 351 210 311 210, Russia 7 095 783 68 51,
Singapore 65 6226 5886, Slovenia 386 3 425 4200,
South Africa 27 0 11 805 8197, Spain 34 91 640 0085,
Sweden 46 0 8 587 895 00, Switzerland 41 56 200 51 51,
Taiwan 886 2 2528 7227, Thailand 662 992 7519,
United Kingdom 44 0 1635 523545

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